Fractionated Stereotactic Radiotherapy

Rationale, indications, & treatment techniques
Radiobiological principles
The graph shows the relationship between survival and dose for different types of ionizing radiation:

- **Densely Ionizing (neutrons or α-rays)**: Plotted as a solid line.
- **Sparsely Ionizing x-rays**: Plotted as a dashed line.

The graph uses a logarithmic scale for survival on the y-axis, ranging from $10^{-3}$ to $10^0$, and a linear scale for dose on the x-axis, ranging from 0 to 16 Gy.

Key points:

- At the origin of the graph, survival is approximately $10^{-3}$.
- The survival decreases rapidly as dose increases, with different slopes for densely and sparsely ionizing radiation.
- The dashed line for sparsely ionizing x-rays passes through the point $(8, 10^{-2})$.

The graph illustrates the differential effects of different radiation types on survival as a function of dose.
The BED (Gy) = $D(1 + \frac{d}{\alpha/\beta})$

Assume $BED_1 = BED_2$ for tissue of an unknown $\alpha/\beta$: 
Optic ret dose = Dose (cGy)/ N^{0.53}
Dose homogeneity

• MDPD ratio:
  Maximum dose/ prescribed dose
Dose conformality

- PTV ratio:
  Prescribed isodose/target volume ratio
<table>
<thead>
<tr>
<th>Isodose prescription</th>
<th>Tumor control rate</th>
<th>Rate of cranial neuropathy</th>
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<td>V</td>
<td>VII</td>
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**Gamma Knife Radiosurgery, 1988-98**

- 18 Gy median: 96 ± 2, 34 ± 8, 33 ± 12, 40 ± 11

**Gamma Knife Radiosurgery, 1998-05**

- 13 Gy median: 97 ± 1, 5 ± 31, 1 ± 12, 59 ± 18

**Conventional Dose Fractionated Stereotactic Radiotherapy**

- 47.5 Gy median: 98 ± 2, 10 ± 5, 5 ± 3, 74 ± 13
logD vs log # of Fractions

$y = 0.4308x + 3.0824$

$R^2 = 0.9705$

y intercept = 3.051

for high rate of hearing preservation
The graph shows the BED (Biologically Effective Dose) and hearing retention doses as a function of the number of fractions. The curve labeled "hearing ret" represents the hearing retention doses, while the curves labeled "alpha/beta = 1.63" and "alpha/beta = 1.81" represent different radiation sensitivity coefficients. The y-axis represents the doses ranging from 0 to 6000, and the x-axis represents the number of fractions ranging from 0 to 45.
ONSM

- Patient 9 with left ONSM with visual field before and 132 weeks after SRT
ONSM

- Patient 6 with right ONSM with visual field before and 170 weeks after SRT
ONSM

- Patient 10 with planum meningioma invading both optic canals with visual fields before and 129 weeks after SRT
Patient 22 with planum meningioma invading both optic canals with visual fields before and 32 weeks after SRT.
ONSM

- Patient 16 with right ONSM in only functioning ON with visual field before and 182 weeks after SRT
ONSM

- Patient 5 with left ONSM (NLP) and chiasm with visual field of functioning ON before and 175 weeks after SRT
Patient 24 with right sphenoid/orbital apex with visual field of functioning ON before and 24 weeks after SRT
Patient 29 with planum/bilateral orbital apex tumor with visual field of only functioning ON before and 32 wks after SRT
Kaplan-Meier Cum. Survival Plot for vision comparing FSR to observation

Probability of vision preservation

Time (weeks)

p = .0345
ONSM: Novalis solution
Acoustic Neuromas
Acoustic Neuromas: tumor control

**Figure 5** Kaplan-Meier plot for probability of tumor control for all patients with follow-up of > 6 months

![Kaplan-Meier plot](plot.png)

<table>
<thead>
<tr>
<th>Probability of tumor control</th>
<th>Time (weeks)</th>
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- SRT (N = 36)
- SRS (N = 62)

$p = .6777$
Acoustic Neuromas: Trigeminal nerve preservation

Figure 6  Kaplan-Meier plot for probability of trigeminal nerve preservation for all patients with follow-up of > 6 months

p = .5231

SRT (N = 40)
SRS (N = 63)
Acoustic Neuromas: Facial nerve preservation

Figure 7  Kaplan-Meier plot for probability of facial nerve preservation for all patients with follow-up of > 6 months

p = .7880

SRT (N = 41)  SRS (N = 56)
Figure 8a  Kaplan-Meier plot for probability of the same Gardner-Robertson hearing grade for all patients

$p = .0461$

8a

SRT (N = 34)

SRS (N = 17)
Acoustic Neuromas: Hearing preservation

Figure 8b  Kaplan-Meier plot for probability of maintaining serviceable hearing grade for all patients

$p = .0228$

- SRT (N = 21)
- SRS (N = 12)
Acoustic Neuromas: Hearing preservation

Figure 8c  Kaplan-Meier plot for probability of maintenance of serviceable hearing by pre-treatment G-R Grade

G-R I (N = 24)
G-R II (N = 10)

p = .0105
Acoustic Neuromas:
Hearing preservation

Figure 8d  Kaplan-Meier plot for probability of maintenance of serviceable hearing in patients with pre-treatment G-R I hearing by treatment group

- SRT (N = 17)
- SRS (N = 7)

$p = .0335$
What about observation?
<table>
<thead>
<tr>
<th>Dose cohort</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
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<tr>
<td></td>
<td>PTA (dB)</td>
<td>SDS (%)</td>
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<td>serviceable (48)</td>
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<td><strong>46.8 Gy</strong></td>
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